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FLOOD INSURANCE STUDY

ORIGINAL

COMPLETED
42

CITY OF GRAND RAPIDS, MICHIGAN
KENT COUNTY

NOVEMBER 1982

Federal Emergency Management Agency

COMMUNITY NUMBER - 260106

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Plaster Creek — Panels 05P-08P

Flood Boundary and Floodway Map Index
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PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map — Panels 260106 0001-0025

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1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this Flood Insurance Study is to investigate the existence and severity of flood hazards in the City of Grand Rapids, Kent County, Michigan, and to aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of this information will be to convert Grand Rapids to the regular program of flood insurance by the Federal Insurance Administration. Further use of the information will be made by local and regional planners in their efforts to promote sound land use and flood plain development.

1.2 Coordination

The community base map was selected and streams requiring detailed study were identified in a meeting attended by representatives of the U.S. Geological Survey, the Federal Insurance Administration, and the City of Grand Rapids in September 1975.

Contacts with the U.S. Soil Conservation Service, the U.S. Army Corps of Engineers, and the Michigan Department of Natural Resources, Bureau of Water Management (the State Coordinator), were made several times during the study in order to minimize all possible conflicts. The City Engineer was also contacted to obtain information.

During the course of the work done by the U.S. Geological Survey, hydrologic analyses, flood elevations, flood boundaries, and floodway delineations were reviewed with community officials, the State Coordinator, and with officials of the Michigan Department of Natural Resources.

On February 23, 1978, the final community coordination meeting was held with all resulting problems having since been resolved. In attendance were officials from the Federal Insurance Administration, the U.S. Geological Survey, and the city.

1.3 Authority and Acknowledgments

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended.

The hydrologic and hydraulic analyses for this study were performed by the U.S. Geological Survey, Water Resources Division, for the Federal Insurance Administration, under Inter-Agency Agreement No. IAA-H-9-77, Project Order No. 2. This work, which was completed in August 1977, covered all significant flooding sources affecting the City of Grand Rapids.

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2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Grand Rapids, Kent County, Michigan. The area of study is shown on the Vicinity Map (Figure 1).

The Grand River and Plaster Creek are the major sources of flooding in Grand Rapids and were studied in detail. Those areas studied by detailed methods were chosen with consideration given to all proposed construction and forecasted development through 1982.

Lamberton Creek, Indian Creek, Brandywine Creek, and a small, unnamed stream in the north-central part of the city cause minor flooding and were studied by approximate methods because no significant development is expected in their flood plains through 1982.

2.2 Community Description

Grand Rapids is located in the southwestern part of Michigan's Lower Peninsula, in western Kent County. In 1970, the population of Grand Rapids was 197,649, an 11.5 percent increase over that of 1960 (Reference 1).

The economy of the area is highly diversified. Manufacturing includes woodworking, textile, tool and die, heat treating, metal plating, metal product, machine tool, foundry, smelter, automobile, chemical, and natural resource industries. Many industrial activities are related to the furniture industry, the principal economic base in the area. Agriculture also is important to the economy of the area. Dairy-related industries and crops, such as corn, wheat, rye, potatoes, beans, and many small fruits, are the prime agricultural segments of the economy.

Transportation facilities include Interstate Highways 96, 196, and 296. U.S. Highway 131 was built to interstate highway standards. State Highways found in the area include 11, 21, 37, 44, and 45. A major air terminal and four railroad lines also serve the area.

Because of the proximity of Grand Rapids to Lake Michigan, the area's climate is influenced appreciably by the lake. During the spring, the cooling effect of the lake results in lower temperatures and retards the growth of vegetation. During the fall, the warming effect of the lake maintains higher temperatures and prolongs the growing season. Winter and summer temperatures are similarly tempered by the lake. Prolonged cold waves with below zero temperatures are infrequent occurrences. Summer heat waves, with temperatures exceeding 100°F, also occur infrequently. The average frost-free season lasts approximately 170 days. The average annual precipitation is 31.19 inches and is fairly uniformly distributed throughout the year. The area receives approximately 80 inches of snow annually.

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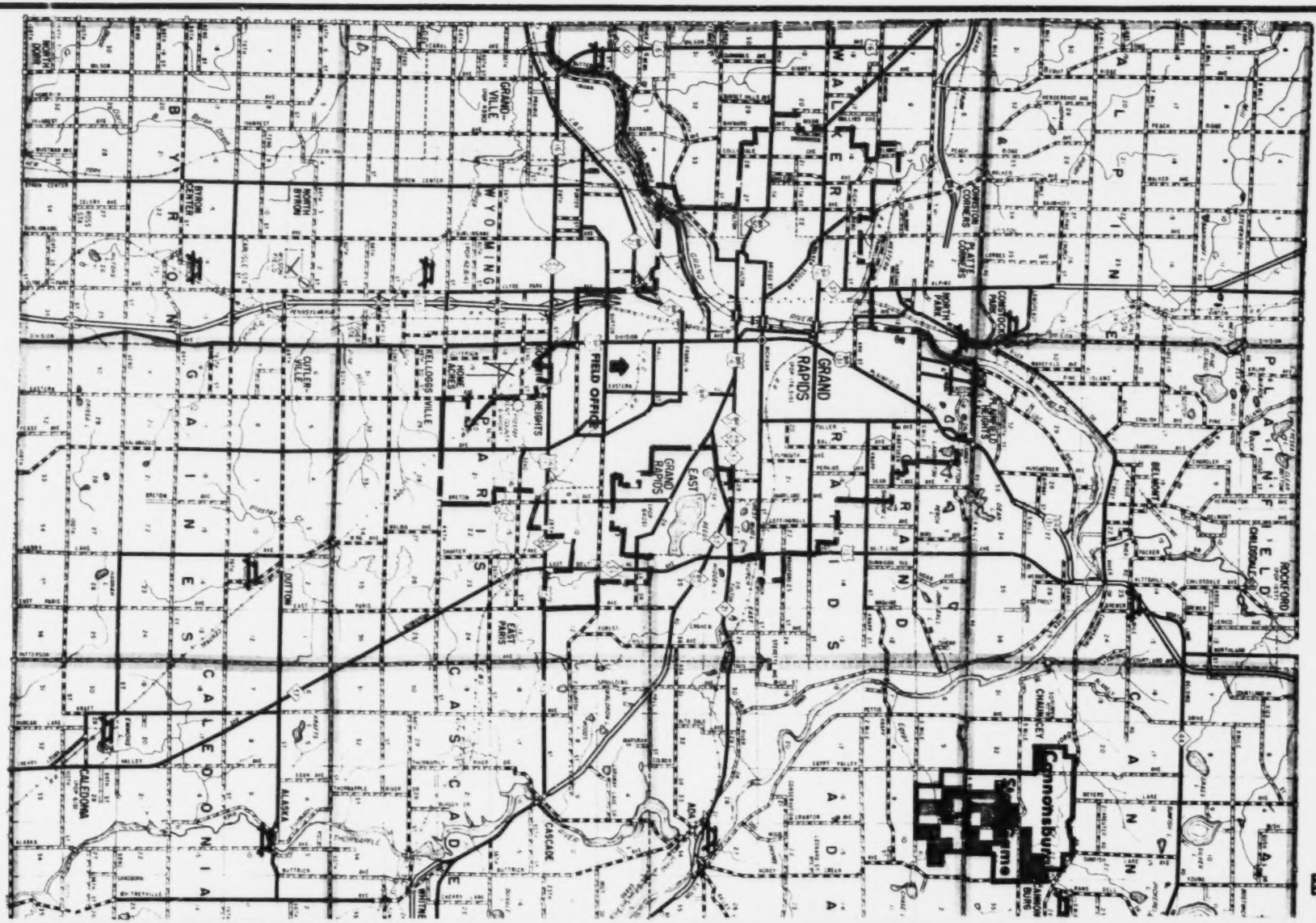

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRAND RAPIDS, MI

(KENT CO.)

APPROXIMATE SCALE

0 2 4 6 8 10 MILES

VICINITY MAP

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The land surface of Grand Rapids is either undulating or moderately hilly, except in areas adjacent to the Grand River. Altitudes range from approximately 590 feet near the Grand River to approximately 830 feet in the northeastern part of the city. Grand Rapids is an established urban community, and most of the community has been developed or is steadily undergoing urbanization.

The Grand River forms a portion of the northern border of Grand Rapids and then flows through the center of the city. Plaster Creek, in the southern part of the city, flows in and out of Grand Rapids and the City of Wyoming.

A considerable amount of development has taken place in the flood plains of the Grand River and the lower section of Plaster Creek. Upstream of Eastern Avenue, development in the flood plain of Plaster Creek has been small, although some residential and commercial development has taken place. Little development has taken place on the flood plains of the smaller streams in Grand Rapids. Continuing economic development is expected, and pressures leading to use of the flood plains may accompany new development.

2.3 Principal Flood Problems

In the past, the Grand River has overflowed its banks, occasionally flooding extensive areas of the City of Grand Rapids. At the 100-year flood stage, the Grand River flood plain, in places, extends from approximately 1000 to 6000 feet into the city. Records of streamflow obtained on the Grand River at Grand Rapids indicate that damaging floods have occurred in March 1904, June 1905, March 1918, March 1919, March 1942, April 1947, March 1948, and April 1960. The greatest flood, that of March 1904, was slightly less than that which would occur once in 100 years. The June 1905 flood had an indicated frequency of approximately once in 5 years. The other floods ranged in frequency to that of 1960 which had a frequency of approximately once in 10 years. Flooding of Plaster Creek, near its mouth, occurs as a result of backwater from the Grand River.

2.4 Flood Protection Measures

After the flood of March 1904, a series of floodwalls and levees were constructed in the City of Grand Rapids to a height of 2 feet above the Grand River flood profile. On the east bank of the Grand River, the floodwall extends from the Conrail tracks to Ann Street. Above Ann Street, a protective levee has been built and extends north to the corporate limits. Downstream of Wealthy Street, Market Avenue forms an effective dike downstream to Plaster Creek. On the west bank of the Grand River, the floodwall or a levee extends from approximately 1500 feet downstream from Wealthy Street to Ann Street. Above Ann Street, State Highway 131 forms a dike. All of these protective works are adequate to prevent flooding from a 100-year flood event.

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3.0 ENGINEERING METHODS

For flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Floods having recurrence intervals of 10, 50, 100, and 500 years have been selected as having special significance for flood plain management and for flood insurance premium rates. The analyses reported here reflect current conditions in the watersheds of the streams.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each stream studied in detail in the community.

For the Grand River, floodflow-frequency data were based on statistical analysis of stage-discharge records for a 75-year period at the gaging station at Grand Rapids. Analyses of the records followed the standard log-Pearson Type III method, as outlined by the U.S. Water Resources Council (Reference 2). Results were coordinated with the State and the U.S. Army Corps of Engineers. For Plaster Creek, peak discharges were based on data previously developed by the U.S. Soil Conservation Service (Reference 3). Crest-gage data for 1974 and 1975 on the stream were also evaluated.

Peak discharge-drainage area relationships for Grand River and Plaster Creek are shown in Table 1.

Table 1. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Year	50-Year	100-Year	500-Year
Grand River					
Along the Entire River	4,900	33,000	48,000	55,000	74,000
Plaster Creek					
From Cross Section A to Cross Section K	58	1,700	2,570	2,950	3,930
From Cross Section L to Cross Section BW	53	1,550	2,350	2,690	3,630

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of streams in the community were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each stream studied in the community.

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Cross sections for the Grand River were obtained from the U.S. Army Corps of Engineers (Reference 4). Cross sections for Plaster Creek were obtained from the U.S. Soil Conservation Service (Reference 3). Additional cross sections for Plaster Creek were taken from topographic maps (Reference 5). Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Water-surface elevations of floods of the selected recurrence intervals were computed through use of the U.S. Geological Survey step-backwater computer program (Reference 6).

Roughness coefficients (Manning's "n") for these computations were assigned on the basis of field inspection of flood plain areas and on previous studies by the U.S. Soil Conservation Service and the U.S. Army Corps of Engineers (References 3 and 4, respectively). Roughness values for the Grand River ranged from 0.025 to 0.035 for the main channel and from 0.04 to 0.10 for the overbanks. Roughness values for Plaster Creek ranged from 0.025 to 0.075 for the main channel and from 0.05 to 0.20 for the overbanks.

Starting water-surface elevations for the step-backwater analyses for the Grand River were determined from the U.S. Geological Survey gaging station on the Grand River near Plaster Creek and from the U.S. Army Corps of Engineers Flood Plain Information report (Reference 4). Starting water-surface elevations for Plaster Creek were developed by the slope-area method. Flooding in the lower section of Plaster Creek results from backwater from the Grand River and the flood elevation shown is that of the Grand River.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1).

Approximate flood elevations were estimated using regional stage-frequency relations.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in the study are shown on the maps.

The hydraulic analyses for this study are based only on unobstructed flow. The flood elevations, as shown on the profiles, are valid only if hydraulic structures, in general, remain unobstructed and dams and other flood control structures described above operate properly and do not fail.

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4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage state and local governments to adopt sound flood plain management programs. Each Flood Insurance Study, therefore, includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Insurance Administration as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For the Grand River, the boundaries of the 100- and 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were developed photogrammetrically, using aerial photographs at a scale of 1:15,840 (Reference 7). For Plaster Creek, the boundaries of the 100- and 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24,000, with a contour interval of 10 feet (Reference 8), and topographic maps at a scale of 1:2,400, with a contour interval of 5 feet (Reference 5). In cases where the 100- and 500-year flood boundaries are close together, only the 100-year flood boundary has been shown.

For streams studied by approximate methods, the boundaries of the 100-year flood were delineated on the basis of regional stage-frequency relations. The boundaries were drawn on topographic maps having scales of either 1:24,000 or 1:2,400, with contour intervals of 10 and 5 feet, respectively (References 5 and 8).

Flood boundaries for the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2).

Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to limitations of the map scale, such areas are not shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity and increases flood heights, thus increasing flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the

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area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment in order that the 100-year flood be carried without substantial increases in flood heights. As minimum standards, the Federal Insurance Administration limits such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. In Michigan though, under Michigan Act 245, Public Acts of 1929, as amended by Act 167, Public Acts of 1968, encroachment in the flood plain is limited to that which will cause only an insignificant increase in flood heights. Thus, at the recommendation of the Michigan Water Resources Commission, Bureau of Water Management, a floodway having no more than a 0.1-foot surcharge has been delineated for this study.

The floodway for this study was computed on the basis of equal conveyance reduction from each side of the flood plain. However, no encroachment was permitted within the floodwalls on the Grand River. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 2).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year flood boundaries are close together, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 0.1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
Plaster Creek							
A	080	72[2]	338	8.74	590.7	590.6[3]	0.1
B	280	48	235	12.53	591.2	591.2[3]	0.0
C	1,000	68	463	6.37	595.2	595.2[3]	0.0
D	1,984	66	331	8.91	598.4	598.4[3]	0.0
E	2,264	152[4]	849	3.47	600.6	600.6[3]	0.0
F	3,327	275[4]	784	3.76	603.1	603.1[3]	0.0
G	4,265	140[4]	589	5.01	606.7	606.6[3]	0.1
H	5,345	85[4]	584	5.05	611.3	611.2	0.1
I	5,445	90[4]	655	4.50	614.1	614.0	0.1
J	5,547	59[4]	404	7.30	614.1	614.1	0.0
K	6,322	77[4]	513	5.75	615.9	615.8	0.1
L	6,412	610[4]	664	4.05	616.2	616.1	0.1
M	6,847	448[4]	488	5.51	617.0	616.9	0.1
N	7,427	95[4]	522	5.15	618.1	618.0	0.1
O	7,767	101[4]	534	5.04	618.6	618.5	0.1
P	8,077	57[4]	436	6.17	619.4	619.3	0.1
Q	8,337	77[4]	457	5.88	620.5	620.4	0.1
R	8,997	374[4]	488	5.51	622.9	622.9	0.0
S	9,487	191/150[5]	476	5.65	624.2	624.1	0.1
T	9,907	56	414	6.50	625.7	625.6	0.1
U	10,132	118	758	3.55	627.1	627.0	0.1
V	10,472	347	1,647	1.63	627.7	627.6	0.1
W	10,732	393	1,375	1.96	628.3	628.2	0.1
X	11,132	460	727	3.70	628.7	628.6	0.1
Y	11,552	274	1,255	2.14	629.8	629.7	0.1
Z	11,694	174	973	2.77	629.8	629.7	0.1

[1]Feet Above Mouth [2]Floodway Computed Without Consideration of Backwater From Grand River
[3]Elevations Shown Without Consideration of Backwater From Grand River
[4]Floodway Located Outside Corporate Limits [5]Width/Width Within Corporate Limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRAND RAPIDS, MI
(KENT CO.)

FLOODWAY DATA

PLASTER CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WITH FLOODWAY	WITHOUT FLOODWAY (FEET NGVD)	DIFFERENCE
Plaster Creek (continued)							
AA	11,812	261	705	3.82	630.1	630.0	0.1
AB	12,732	264	1,127	2.39	631.8	631.7	0.1
AC	13,580	434/110[2]	1,627	1.65	632.6	632.5	0.1
AD	14,896	508[3]	901	2.99	634.9	634.8	0.1
AE	15,476	380[3]	1,344	2.00	637.1	637.0	0.1
AF	15,740	705[3]	847	3.18	638.1	638.0	0.1
AG	16,081	754[3]	1,323	2.03	638.9	638.8	0.1
AH	16,184	386[3]	1,519	1.77	639.4	639.3	0.1
AI	16,794	774[3]	2,926	0.92	639.9	639.8	0.1
AJ	17,086	625[3]	990	2.72	640.1	640.0	0.1
AK	17,463	74[3]	532	5.06	641.0	641.0	0.0
AL	17,559	77	612	4.39	642.0	641.9	0.1
AM	18,419	657	1,358	1.98	644.7	644.6	0.1
AN	19,299	486	765	3.52	647.1	647.0	0.1
AO	20,059	86	675	3.99	649.3	649.3	0.0
AP	20,157	313	1,795	1.50	650.1	650.0	0.1
AQ	21,237	554	1,626	1.65	651.0	650.9	0.1
AR	22,297	321	1,053	2.55	653.2	653.1	0.1
AS	22,757	116	721	3.73	654.7	654.6	0.1
AT	23,262	282	1,604	1.68	655.7	655.6	0.1
AU	23,364	288	1,888	1.42	656.7	656.6	0.1
AV	23,784	364	1,801	1.49	656.9	656.8	0.1
AW	24,160	572	2,812	0.96	657.0	656.9	0.1
AX	24,894	84	520	5.17	657.7	657.6	0.1
AY	25,319	479	899	2.99	659.6	659.5	0.1
AZ	25,414	712	1,436	1.87	660.1	660.0	0.1

[1]Feet Above Mouth [2]Width/Width Within Corporate Limits
[3]Floodway Located Outside Corporate Limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRAND RAPIDS, MI

(KENT CO.)

FLOODWAY DATA

PLASTER CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WITH FLOODWAY	WITHOUT FLOODWAY (FEET NGVD)	DIFFERENCE
Plaster Creek (continued)							
BA	26,454	352	1,876	1.43	660.7	660.6	0.1
BB	26,980	706	4,073	0.66	660.9	660.8	0.1
BC	28,124	292	1,444	1.86	661.1	661.1	0.0
BD	28,680	376	2,103	1.28	661.4	661.4	0.0
BE	29,459	296	752	3.58	662.2	662.1	0.1
BF	30,100	185	1,434	1.88	663.3	663.2	0.1
BG	31,300	106	758	3.55	664.2	664.1	0.1
BH	32,134	268	1,106	2.43	665.6	665.5	0.1
BI	32,980	137	849	3.17	666.9	666.8	0.1
BJ	33,914	295	1,302	2.07	668.3	668.2	0.1
BK	34,614	83	515	5.23	669.8	669.7	0.1
BL	34,736	141	1,244	2.16	671.8	671.7	0.1
BM	35,611	378	1,859	1.45	672.3	672.2	0.1
BN	36,151	279	1,115	2.41	672.6	672.5	0.1
BO	36,676	467	2,024	1.33	673.0	672.9	0.1
BP	37,091	316	1,147	2.34	673.2	673.1	0.1
BQ	38,261	172	1,235	2.18	674.0	673.9	0.1
BR	40,076	117	803	3.35	675.3	675.3	0.0
BS	40,881	138	1,060	2.54	676.2	676.1	0.1
BT	42,364	381	3,014	0.89	676.7	676.6	0.1
BU	42,554	94	730	3.68	676.7	676.6	0.1
BV	42,604	382	3,089	0.87	676.9	676.8	0.1
BW	44,094	350	1,923	1.40	677.2	677.1	0.1

[1]Feet Above Mouth

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRAND RAPIDS, MI

(KENT CO.)

FLOODWAY DATA

PLASTER CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
Grand River							
A	198,860	1850/720[2]	29,439	1.87	606.6	606.5	0.1
B	199,160	2000/740[2]	22,546	2.44	606.6	606.5	0.1
C	203,590	1100	18,529	2.97	607.6	607.5	0.1
D	205,120	1100	18,685	2.94	607.8	607.7	0.1
E	208,420	950	14,786	3.72	608.2	608.1	0.1
F	210,690	538	12,740	4.32	608.6	608.5	0.1
G	212,160	418	10,633	5.17	608.8	608.7	0.1
H	212,800	518	10,951	5.02	609.0	608.9	0.1
I	213,700	472	11,216	4.90	609.2	609.1	0.1
J	215,240	492	12,065	4.56	609.5	609.4	0.1
K	215,770	500	10,283	5.33	609.7	609.6	0.1
L	216,250	499	9,710	5.55	610.2	610.1	0.1
M	216,870	499	9,991	5.50	610.7	610.7	0.0
N	217,470	524	10,754	5.11	611.0	610.9	0.1
O	217,720	504	9,952	5.53	611.0	610.9	0.1
P	219,070	533	9,623	5.72	611.6	611.5	0.1
Q	219,650	585	9,744	5.63	614.7	614.6	0.1
R	221,940	585	9,024	6.09	615.3	615.3	0.0
S	224,400	615	9,126	6.03	616.2	616.2	0.0
T	226,640	691	12,258	4.49	617.0	617.0	0.0
U	227,180	650	11,763	4.68	617.1	617.1	0.0
V	230,780	1400/740[2]	17,054	3.22	617.7	617.7	0.0
W	233,530	2300/1600[2]	23,370	2.35	618.1	618.1	0.0
X	237,480	1200/350[2]	14,671	3.75	618.5	618.4	0.1
Y	240,540	1200/750[2]	17,174	3.20	619.0	619.0	0.0

[1]Feet Above Mouth [2]Width/Width Within Corporate Limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRAND RAPIDS, MI
(KENT CO.)

FLOODWAY DATA

GRAND RIVER

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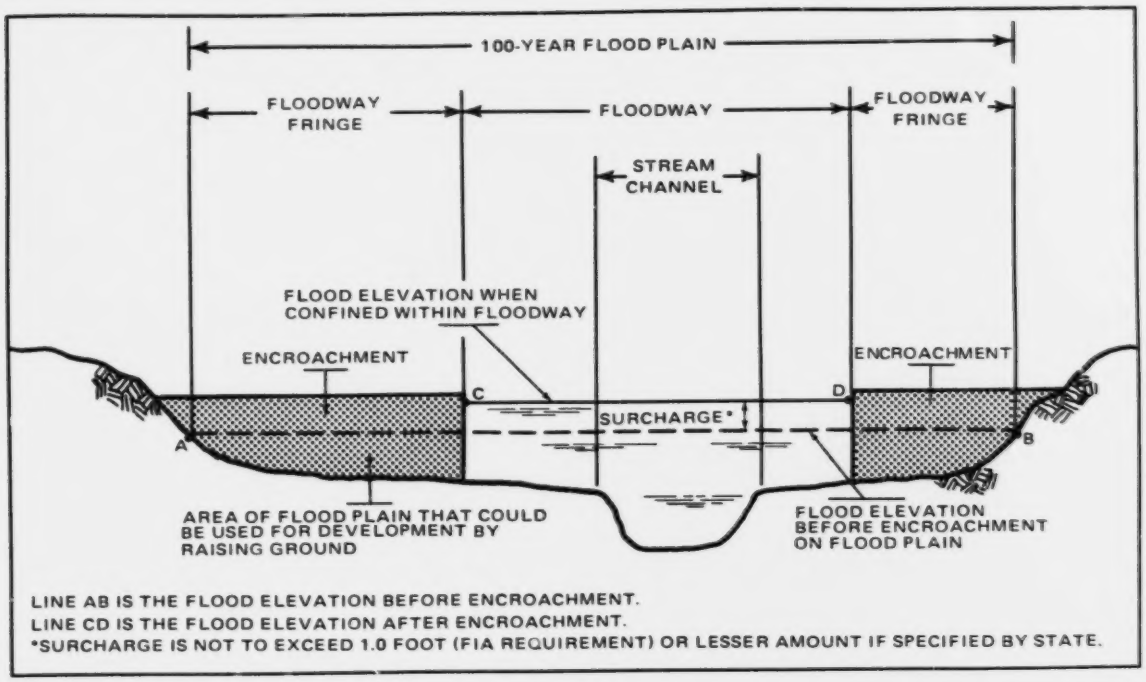
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FIA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

Figure 2. Floodway Schematic

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the Federal Insurance Administration has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail affecting the City of Grand Rapids.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

Average Difference Between 10- and 100-year Floods	Variation
2 to 7 feet	1.0 foot

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Four reaches meeting the above criterion were required for the flooding sources of Grand Rapids. These included three on Plaster Creek and one on Grand River. The locations of the reaches are shown on the Flood Profiles (Exhibit 1).

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is the Federal Insurance Administration device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHF are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest one-half foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective Flood Hazard Factors, the entire incorporated area of the City of Grand Rapids was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or Flood Hazard Factors determined.
Zones A4, A5, A6, and A8:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to Flood Hazard Factors.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; also areas subject to certain types of 100-year shallow flooding where depths are less

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than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding.

The flood elevation differences, Flood Hazard Factors, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community are summarized in Table 3.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Grand Rapids is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the Federal Insurance Administration.

6.0 OTHER STUDIES

A Flood Plain Information report for the Grand River was prepared by the U.S. Army Corps of Engineers in 1972 (Reference 4). Using much of the data from the report, a Flood Insurance Study was completed by the U.S. Geological Survey in December 1975. Upon review of the Flood Insurance Study and additional streamflow data, the City of Grand Rapids requested a reexamination of the flood profiles for the Grand River using lower discharges for the 10-, 50-, 100-, and 500-year recurrence intervals. Lower discharges were warranted on the basis of additional streamflow data and frequency analyses as outlined in U.S. Water Resources Council Bulletin 17 (Reference 2). The Michigan Department of Natural Resources approved the lower discharges for use in this Flood Insurance Study.

A Flood Hazard Analysis of Plaster Creek was prepared by the U.S. Soil Conservation Service in 1971 (Reference 3). Flood profiles for Plaster Creek are the same as for that report, except in the lower reaches. Flood elevations are lower near the mouth of the stream because of lower profiles on the Grand River.

A Flood Insurance Study for the City of Wyoming was prepared by the U.S. Geological Survey, Water Resources Division, Okemos, Michigan (Reference 9). Water-surface elevations presented in the Wyoming study for Grand River and Plaster Creek are higher than those presented in this study; however, that study is being revised using new discharge data.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Grand River							
Reach 1	0015	-4.1	-1.1	2.8	040	A8	Varies-See Map
Reach 2	0010, 0015, 0020	-4.4	-1.3	4.4	045	A9	Varies-See Map
Plaster Creek							
Reach 1	0015, 0020	-2.8	-0.4	1.0	030	A6	Varies-See Map
Reach 2	0025	-2.1	-0.5	1.2	020	A4	Varies-See Map
Reach 3	0025	-2.3	-0.6	1.6	025	A5	Varies-See Map

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRAND RAPIDS, MI
(KENT CO.)

FLOOD INSURANCE ZONE DATA

GRAND RIVER-PLASTER CREEK

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This study is authoritative for the purposes of the National Flood Insurance Program; data presented herein either supersede or are compatible with all previous determinations.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, 300 South Wacker Drive-24th Floor, Chicago, Illinois 60606.

8.0 BIBLIOGRAPHY AND REFERENCES

1. U.S. Department of Commerce, Bureau of the Census, 1970 Census of Population, July 1971

2. U.S. Water Resources Council, "Guidelines for Determining Flood Flow Frequency," Bulletin 17, March 1976

3. U.S. Department of Agriculture, Soil Conservation Service, Flood Hazard Analysis, Plaster Creek, Kent County, Michigan, June 1971

4. U.S. Department of the Army, Corps of Engineers, Flood Plain Information, Grand River, Grand Rapids, Michigan and Vicinity, 1972

5. Abrams Aerial Survey Corporation, Topographic Maps, Scale 1:2400, Contour Interval 5 feet: Grand Rapids, Michigan (1963)

6. U.S. Department of the Interior, Geological Survey, Open-File Report No. 76-499, Computer Applications for Step-Backwater and Floodway Analyses, J. O. Shearman, 1976

7. Abrams Aerial Survey Corporation, Aerial Photographs, City of Grand Rapids, Michigan, Scale 1:15,840, April 6, 1974

8. U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 10 feet: Grand Rapids West, Michigan (1967), Photorevised (1972); Grand Rapids East, Michigan (1967), Photorevised (1972)

9. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, City of Wyoming, Michigan, prepared by the U.S. Geological Survey, Okemos, Michigan, (unpublished)

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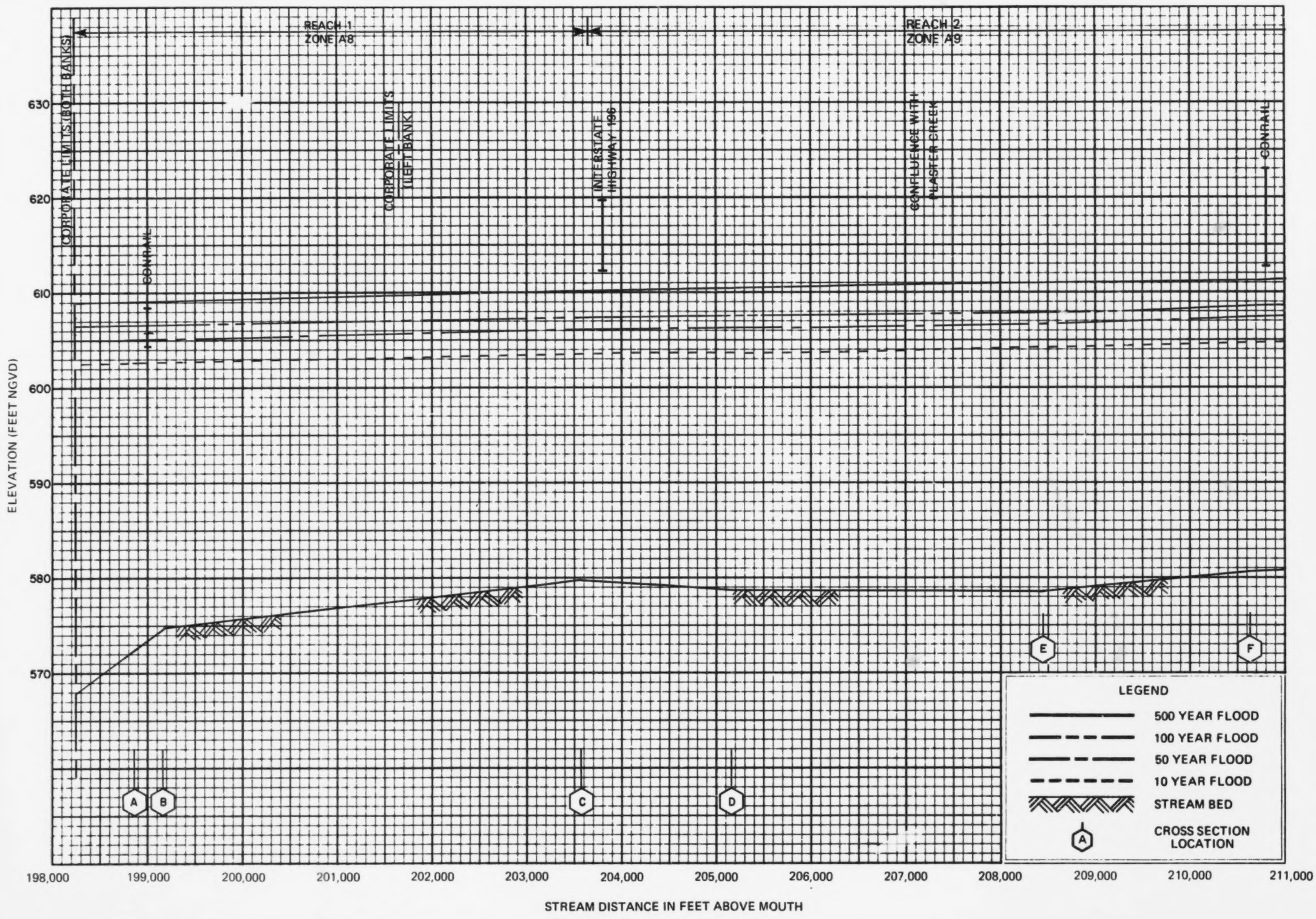

FLOOD PROFILES

GRAND RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRAND RAPIDS, MI
(KENT CO.)

01P

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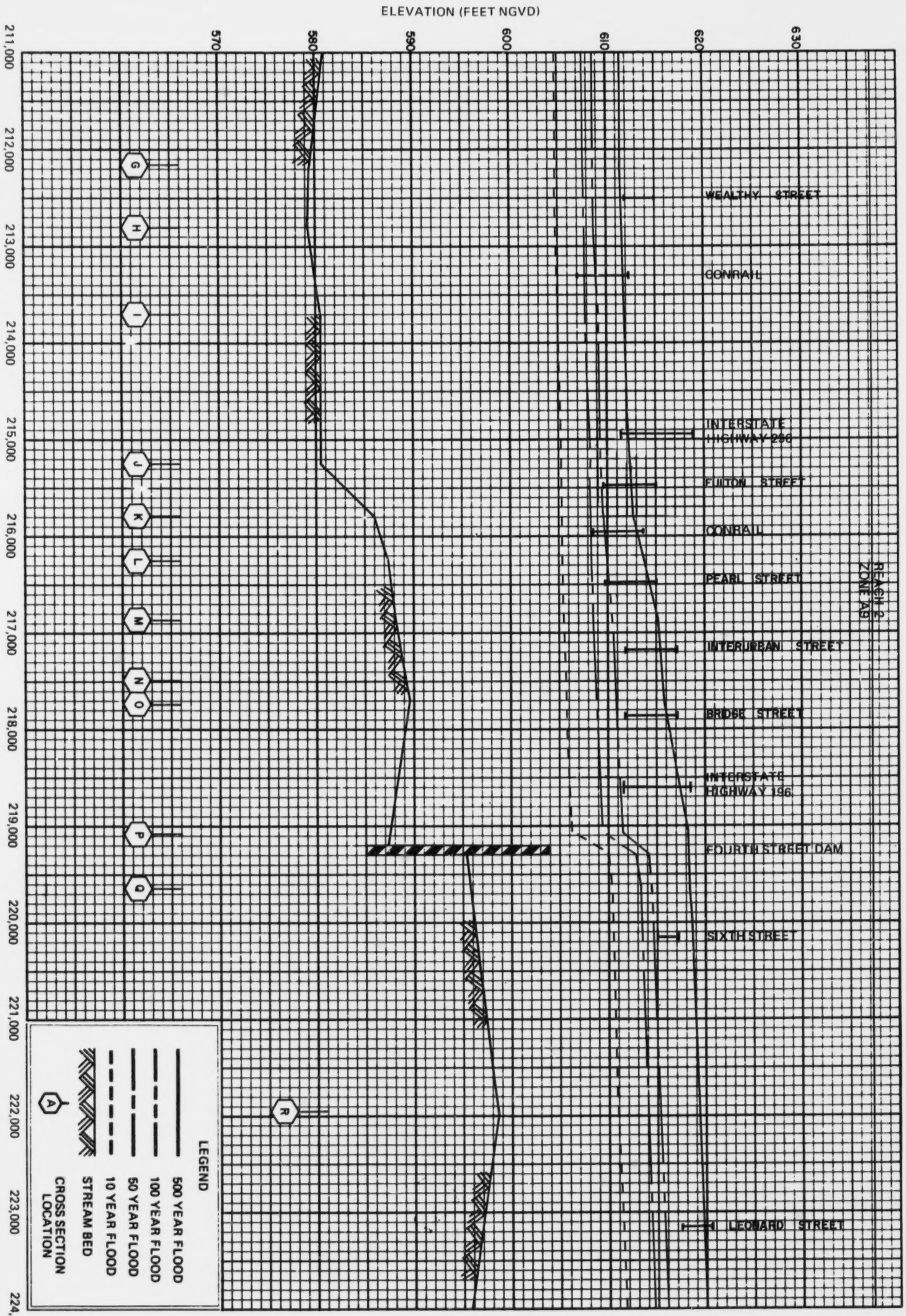

02P

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRAND RAPIDS, MI
(KENT CO.)

FLOOD PROFILES

GRAND RIVER

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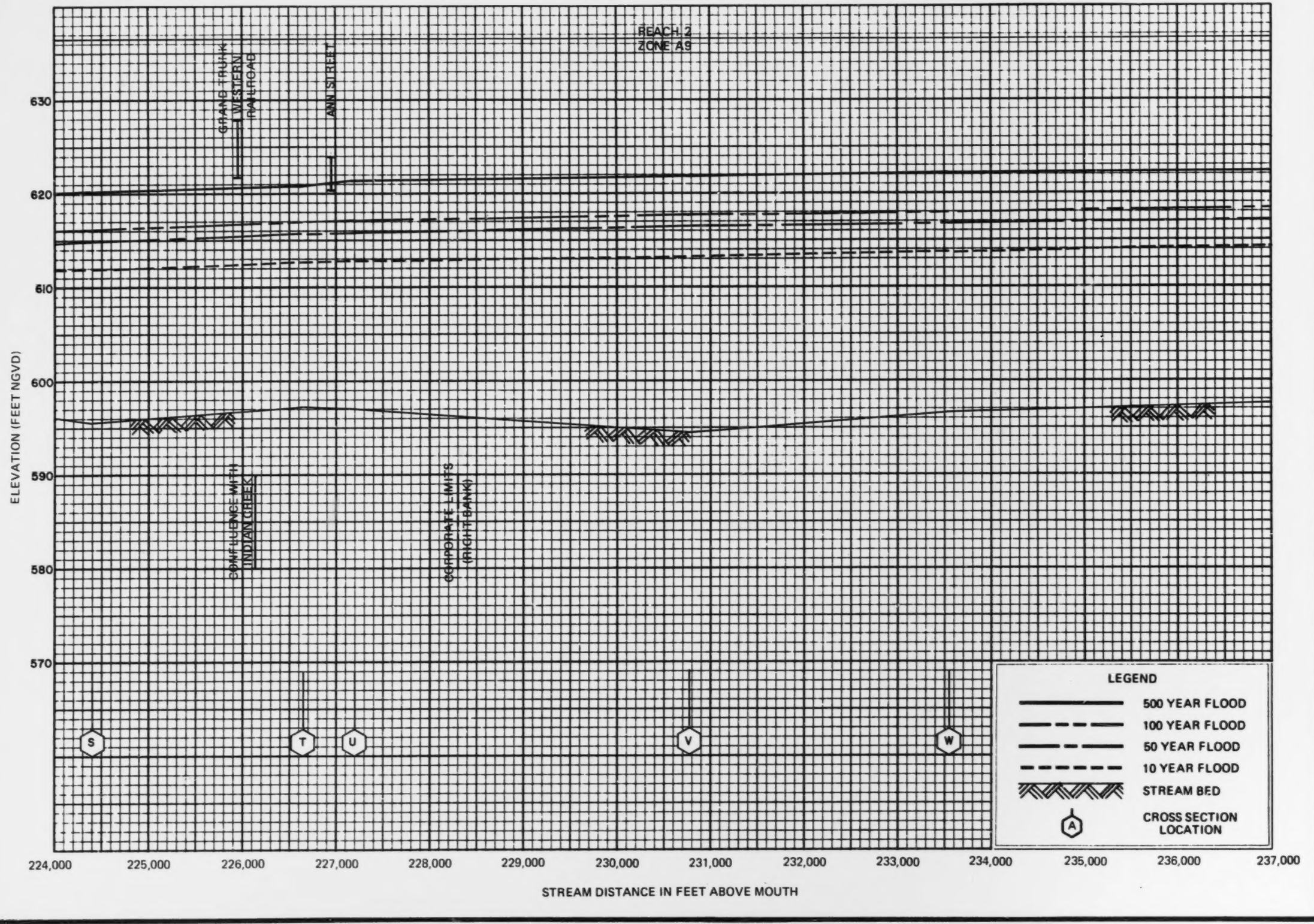

FLOOD PROFILES

GRAND RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRAND RAPIDS, MI
(KENT CO.)

03P

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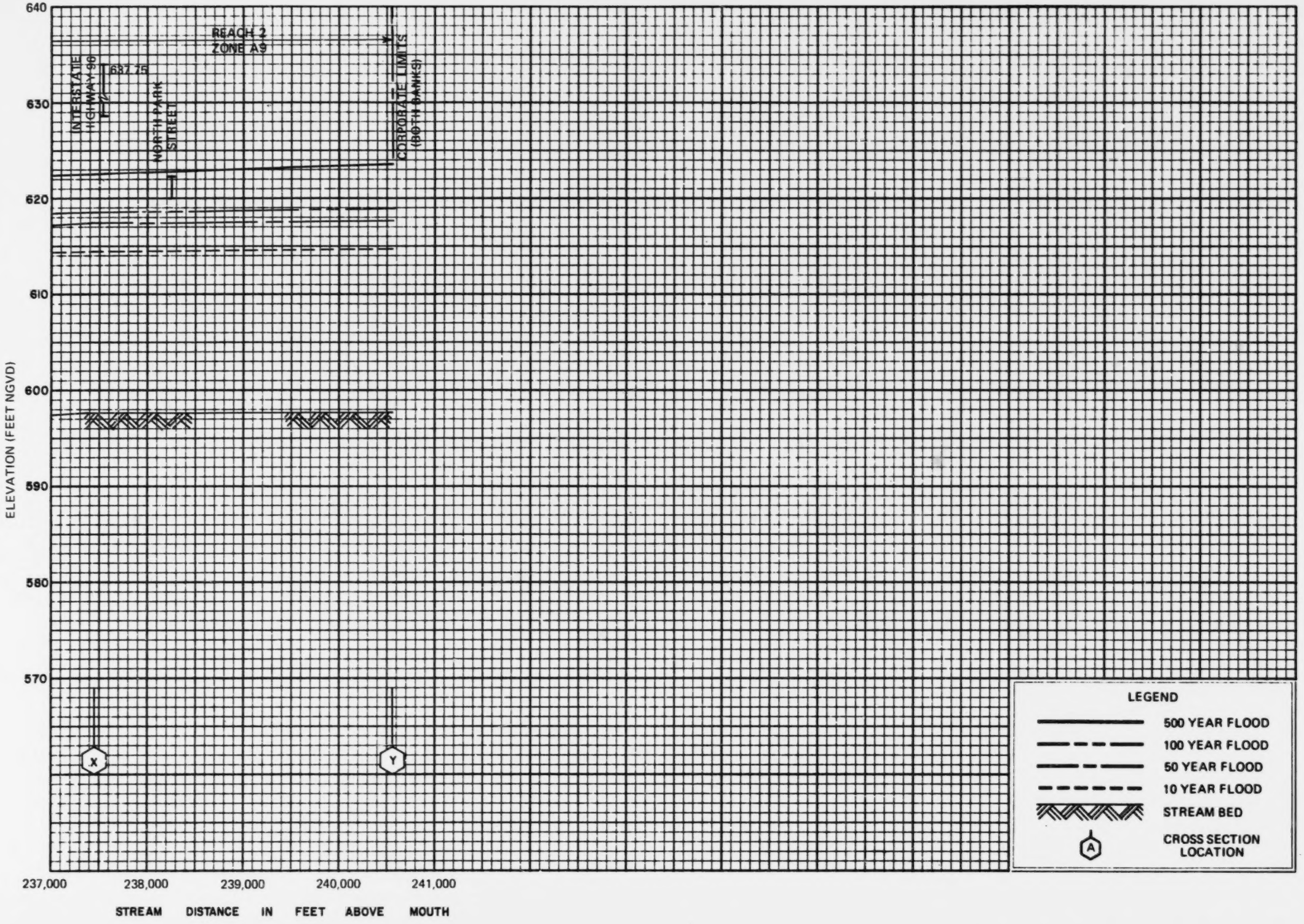

FLOOD PROFILES

GRAND RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRAND RAPIDS, MI
(KENT CO.)

04P

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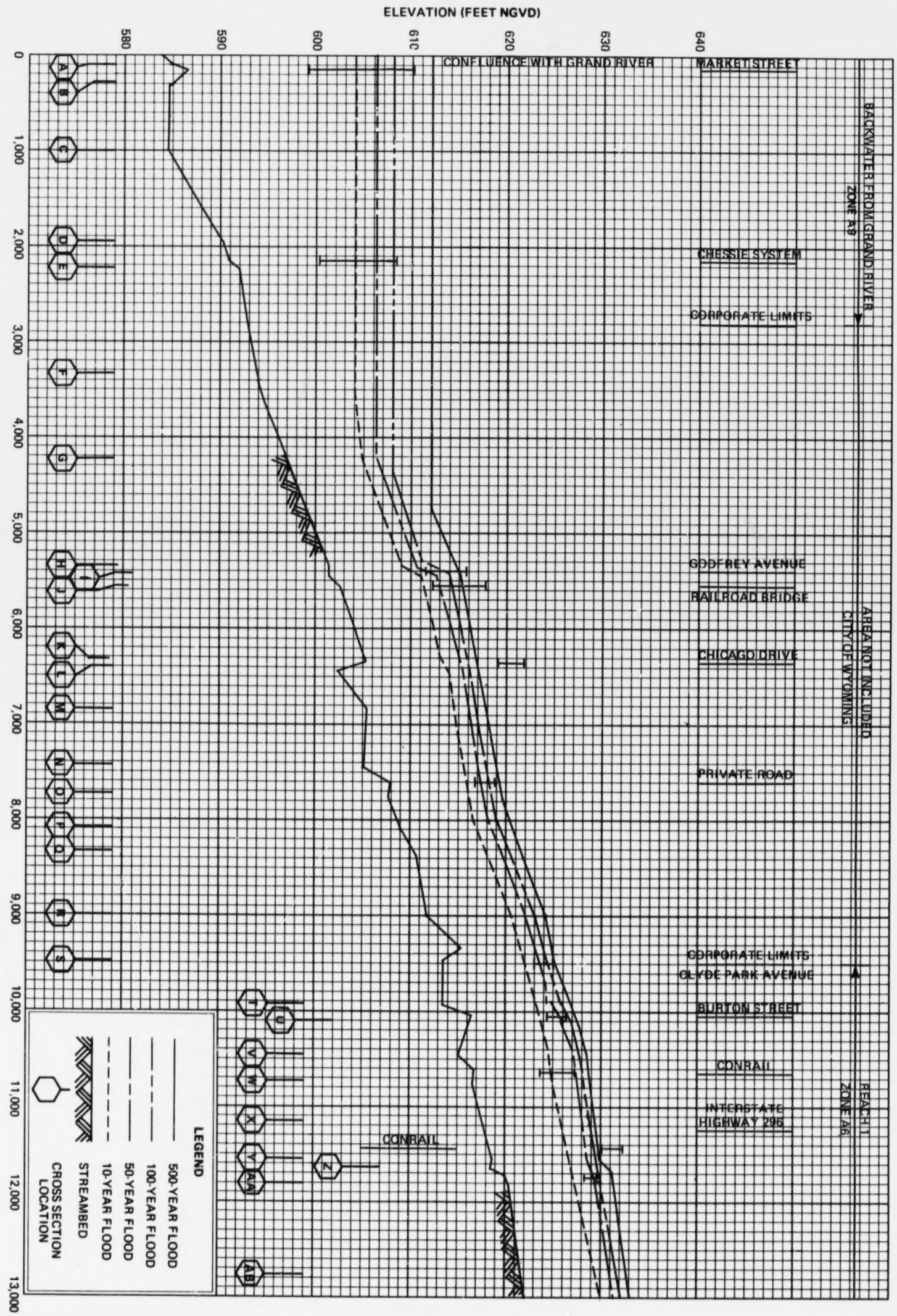

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FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRAND RAPIDS, MI

(KENT CO.)

FLOOD PROFILES

PLASTER CREEK

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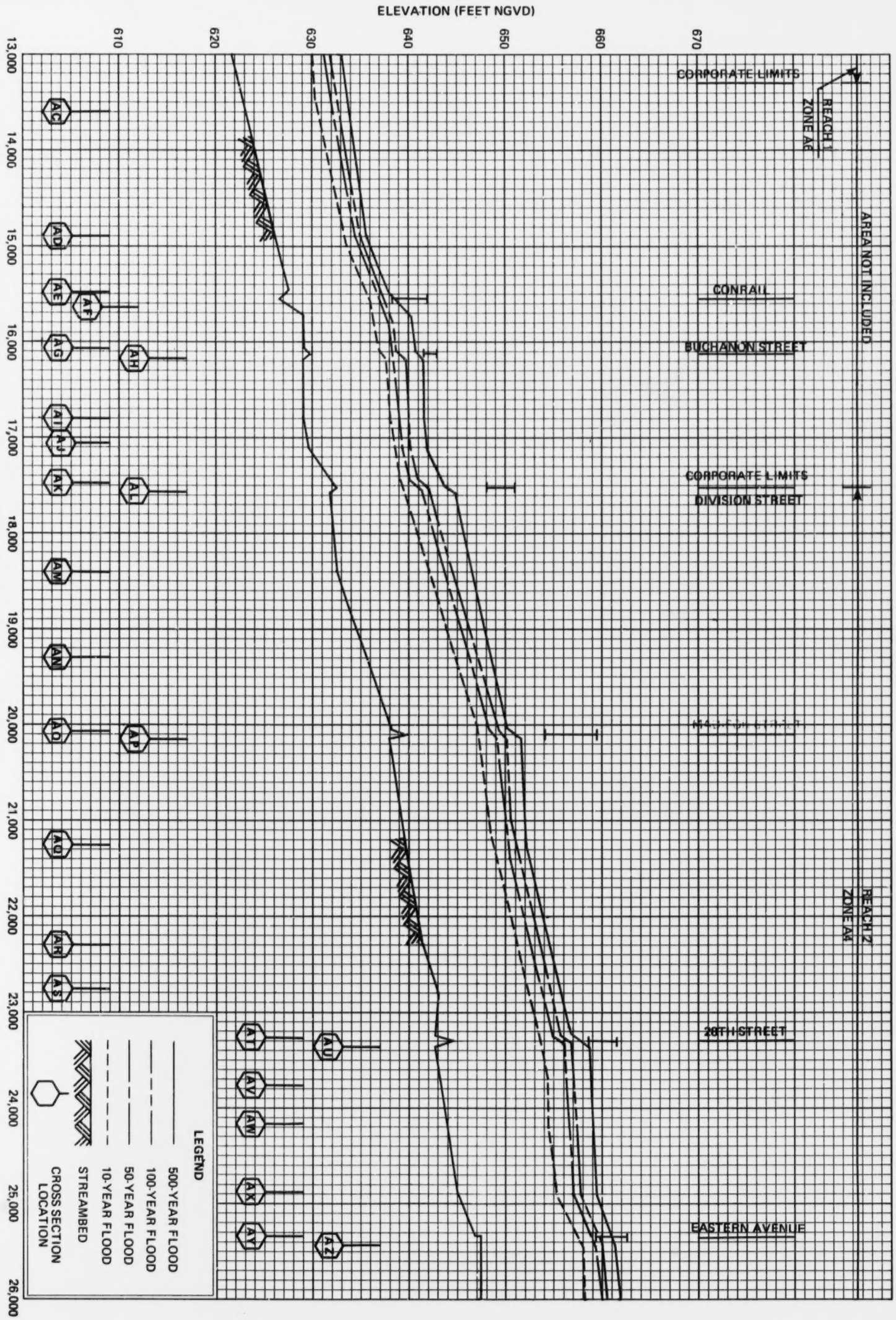

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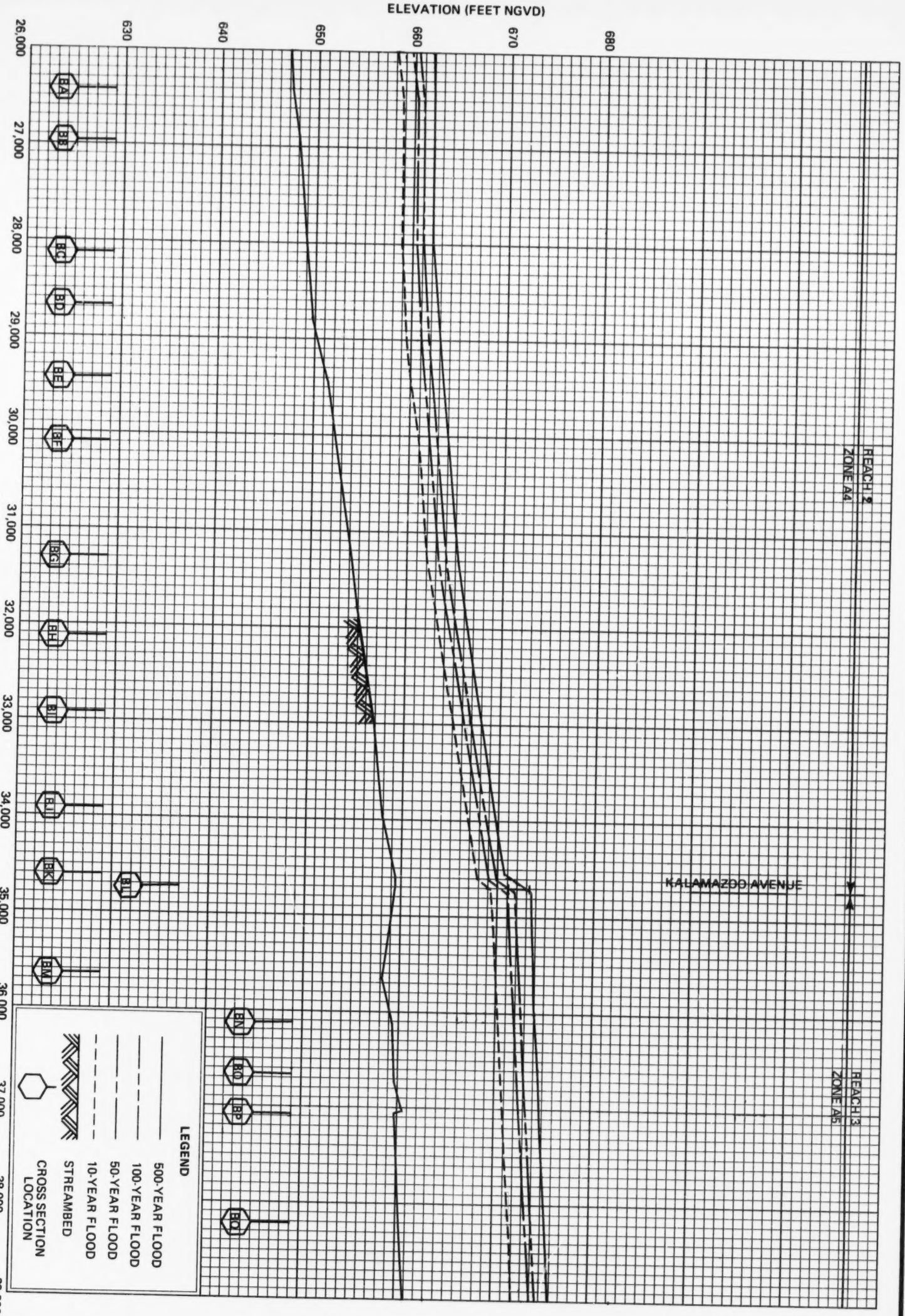

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRAND RAPIDS, MI

(KENT CO.)

FLOOD PROFILES

PLASTER CREEK

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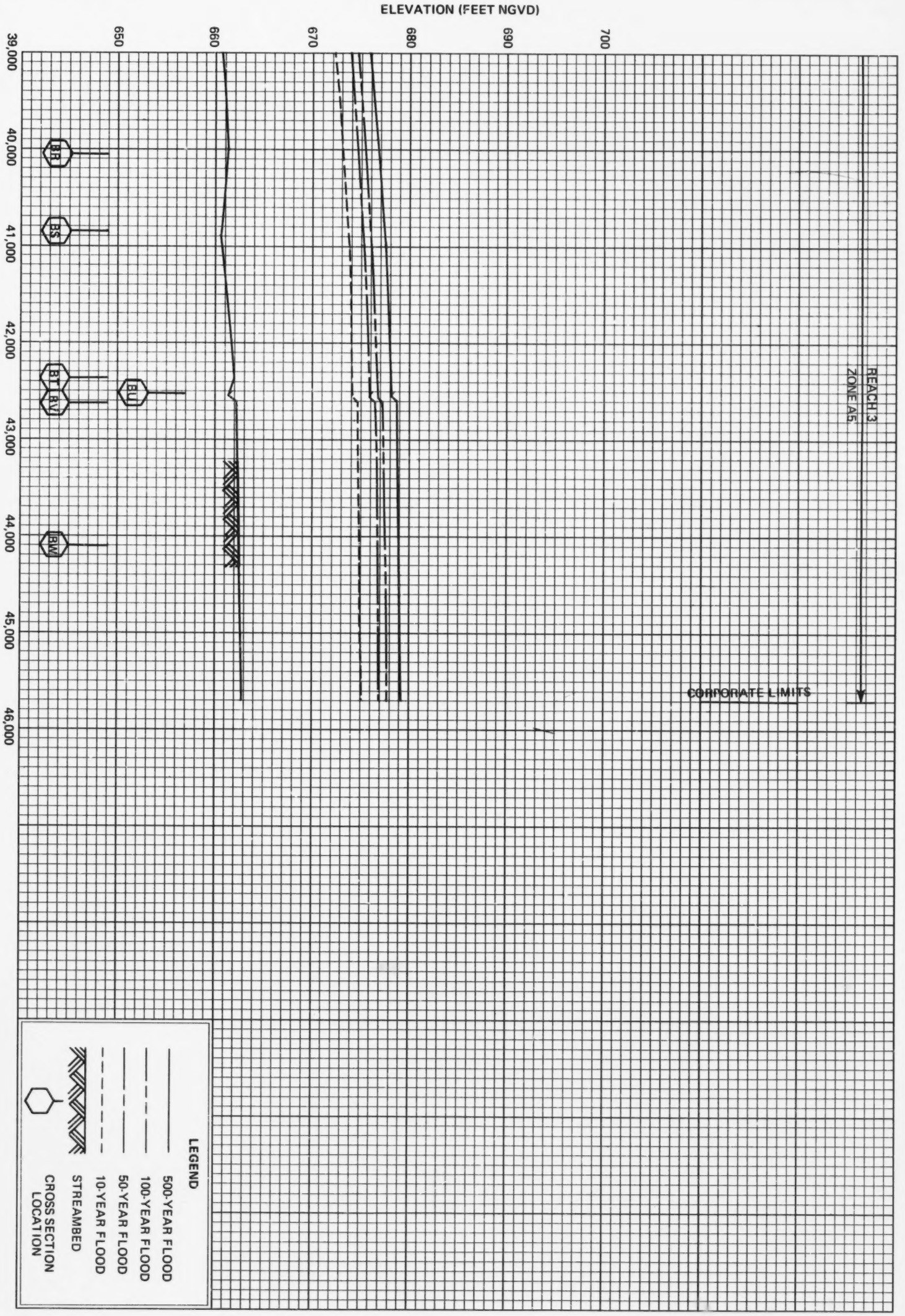

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